Title: The Smart Move Wins (Is This a "Fair Game"?)

Brief Overview:

Students will be organized into groups (2 to 4) to play The Smart Move Wins, to analyze the results, and determine the fairness of the game.

Link to Standards:

- **Problem Solving** Students will demonstrate their ability to solve mathematics problems through the use of open ended answers solved cooperatively.
- **Communication** Students will demonstrate their understanding of probability in their written responses and in their verbal interactions while simulating the game.
- **Reasoning** Students will demonstrate their ability to reason mathematically. The learners will conduct experimental probability. They will also analyze the data and make conclusions.
- **Connections** Students will compare their theoretical probabilities with experimental probabilities. Students bring to this lesson a prior sense of fairness through other games that they have played.
- **Number & Number Relationships** The students will represent probability in fractional form and describe the relationship among fractions.
- **Statistics** The students will learn the meaning of analyzing data by writing an evaluative argument to explain the fairness of a game.

Grade/Level:

Grades 7/8

Duration/Length:

This activity will take two to three 45 minute class periods.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Determining probability using tree diagrams
- Writing and interpreting fractions
- Using independent probability

Objectives:

Students will:

- work cooperatively in groups.
- predict and then experiment to determine probabilities.
- determine probability of independent events using tree diagrams.

- analyze and evaluate the fairness of a game.
- design and construct their own fair game.

Materials/Resources/Printed Materials:

- Paper
- Pennies
- Pencils
- Student worksheets 1-6
- Teacher Resources
- Playing chips

Development/Procedures:

- Place students in groups of two.
- Review game rules.
- Compare the scientific method to our method of game exploration.
- Make predictions (hypothesize).
- Play the game in pairs.
- Reevaluate your prediction.
- Play the game two more times.
- Predict the winner of future games.
- Determine the theoretical probabilities.
- Make the game fair.

Assessment:

- The students will make corrections to and determine fairness of "The Smart Move Wins."
- Have each group create and develop their own fair game.
- This section will be performance-based (a performance assessment task) in accordance with Maryland's move to performance-based assessment.

Extension/Follow-up:

- Students will exchange their newly created game with another team.

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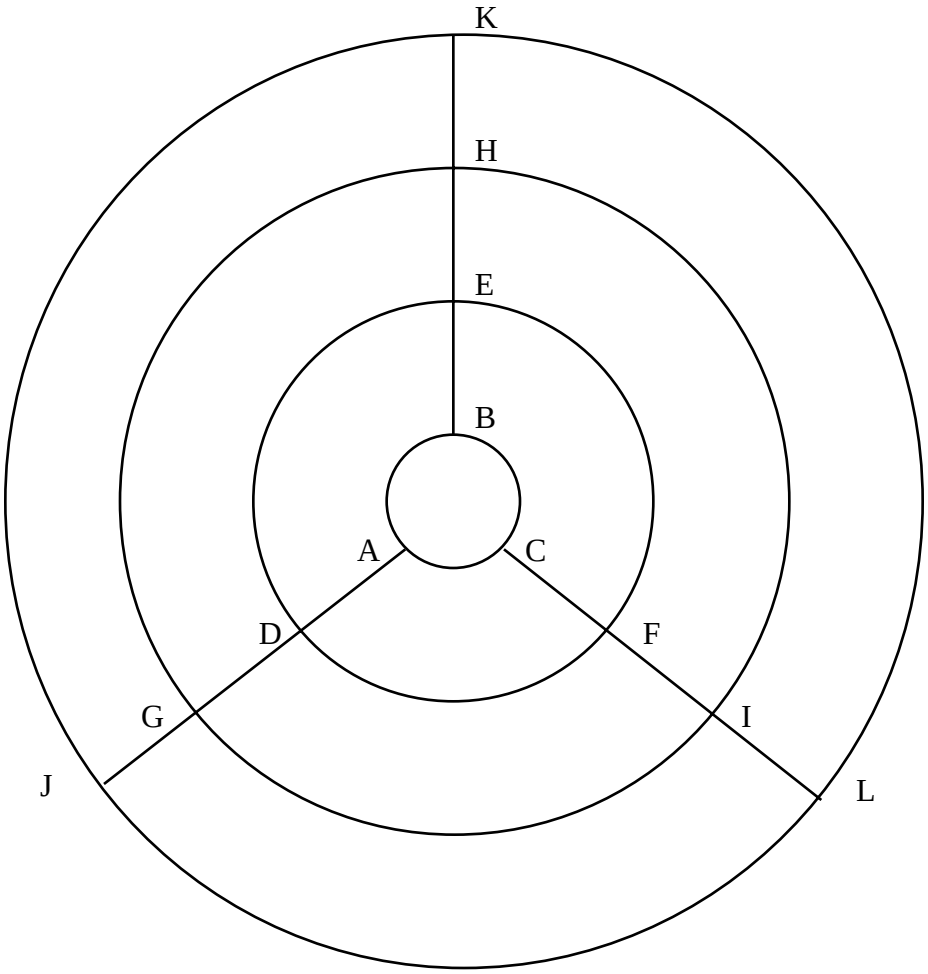

THE SMART MOVE WINS!

TURN:	#1 LOCATION	POINT	#2 LOCATION	POINT
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____
5	_____	_____	_____	_____
6	_____	_____	_____	_____
7	_____	_____	_____	_____
8	_____	_____	_____	_____
9	_____	_____	_____	_____
10	_____	_____	_____	_____
11	_____	_____	_____	_____
12	_____	_____	_____	_____
13	_____	_____	_____	_____
14	_____	_____	_____	_____
15	_____	_____	_____	_____

THE SMART MOVE WINS!

RULES OF PLAY

•Player 1: Starts at point A and tries to move to point J.

•Player 2: Starts at point B and tries to move to point L.

•A player makes a move by flipping three coins.

•A player moves according to his/her flip of the three coins. A head is allowed one space and a tail is allowed two spaces.

Sample turn: Student flips Heads, Heads, and Tails.

FLIPS		MOVES		TOTAL MOVES
H + H + T	->	1 + 1 + 2	->	4

•Players may slide either along the circumference of the circle or outward along the path to a new circle, always to the next intersection point.

•A TURN consists of each player flipping a coin three times.

•A player earns a point for a turn by landing on his/her endpoint after moving.
{Remember: you must land on your endpoint to score a point!!!!}

•Players mark their location and score on the round sheet, then return their playing chips to their starting points.

•A GAME ends when one player reaches 10 points.

THE SMART MOVE WINS!

EXPERIMENT

1. Before playing, predict who will win the game, and describe why you think that player will win.

2. Play the game now. Keep a record of your game on the score sheet.

3. Look at the results of the game. Does your prediction in #1 hold? (Whether you say yes or no, use the results of your simulation to support your answer.)

4. Play the game 2 more times. Keep a record of your games on the score sheet.

5. Based on your simulations, predict who you believe would win any further games. State why you believe that person will win.

THE SMART MOVE WINS!
SCORE SHEET

TURN	#1 LOCATION	#1 POINT	#2 LOCATION	#2 POINT
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

TURN	#1 LOCATION	#1 POINT	#2 LOCATION	#2 POINT
1				
2				
3				
4				
5				
6				
7				
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14				
15				

TURN	#1 LOCATION	#1 POINT	#2 LOCATION	#2 POINT
1				
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3				
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THE SMART MOVE WINS!

PROBABILITY CALCULATION

1. Create a tree diagram to determine all of the possible outcomes of flipping a coin three times.

2. List the possible outcomes, possible destinations, and points awarded.

OUTCOMES	MOVES	A's DESTINATION	A's POINTS	B's DESTINATION	B's POINTS

3. What are the probabilities of each player earning a point on a turn?

4. Do your calculated results agree or disagree with your experimental results? Explain your answer.

THE SMART MOVE WINS! ASSESSMENT #1

MAKE IT FAIR

1. What does the word fair mean?

2. Is our game fair? Why or why not?

3. Change the game so that it will be fair. Describe any rule changes necessary and calculate the new probabilities for the players in your game.

THE SMART MOVE WINS! ASSESSMENT #2

MAKE YOUR OWN GAME

By now, you know that "The Smart Move Wins" is not a fair game, and you have analyzed why. If you were a designer in a toy company, the smart move would be to pull this game off the market and replace it with a fair one.

And that is precisely what you can do! To make sure you have a quality product, include the following details.

*A board for players to use. It may model a real place or game, and should have "spaces", a "beginning", and an "end" so players know how to move. Be creative!

*Some random element that determines the flow of play.

Examples: Coin flip
Spinner
Dice
Cards

*Clear, written rules for movement, scoring, and winning.

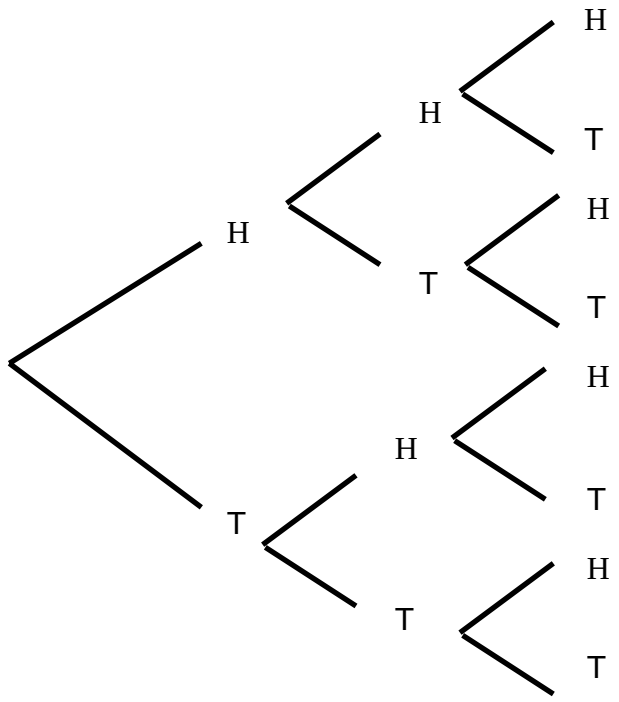
*A statement of fairness, in which you describe, using probability theory, why your game is fair.

You upset many consumers by marketing "The Smart Move Wins." Here is your chance to make it up to them!

Scoring Guide: The Smart Move Wins!

Probability Calculations:

1.)



2.)

OUTCOMES/ MOVES		A's DESTINATION	A's POINTS	B's DESTINATION	B's POINTS
HHH	3	J	1	D F G I K	0
HHT	4	G L F D K I E	0	L	1
HTT	5	J	1	L	1
HTH	4	G L F D K I E	0	L	1
TTH	5	J	1	L	1
TTT	6	J	1	L	1
THT	5	J	1	L	1
THH	4	G L F D K I E	0	L	1

3.) P(player one) = 5/8 P(player two) = 7/8

Scoring Guide: The Smart Move Wins!! "Make It Fair"

1.) The student should be able to describe the meaning of fair using complete sentences.

2.) The student should make a decision about the fairness of the game. The game is not fair. The student should support their decision using complete sentences.

3.) The student will make appropriate adjustments to the game to make it a FAIR game for both players.

Scoring Rubric for "Make it Fair"

3 - Student will change the game to make it fair for both players. The student will accurately explain at least one way to change the game using complete sentences and/or models.

2- Student will change the game to make it fair for both players. The student will attempt to explain at least one way to change the game using complete sentences and/or models.

1- Student will attempt to change the game to make it fair for both players. Explanation was confusing.

0- Student did not answer or answer is unscorable.

Possible Ways to Change the Game to Make It Fair:

1.) Change the ending destination of player number one from J to either K or L. This creates equal probabilities for each player - that being P(landing on their destination) = 7/8.
2.) Change the value of the heads from one move to two moves. Therefore, each player has a probability of 1/8 to land on their destination point.
3.) Change the ending destination of player number two from L to K. This creates equal probabilities for each player - that being P(landing on their destination) = 5/8.
4.) Have both players start at the same point and have the same final destination.
5.) Have both players start at the same point and have different destinations. For example:

Both players start at point A.
Player #1 earns a point by landing on point K.
Player #2 earns a point by landing on point L.

Scoring Rubric for "Make Your Own Game"

4- All required elements are included.
The game and packaging is neat and attractive.
The game is fun and easy to play.
All directions are included, clearly defined, and simple.
Students use theoretical probability in fraction or decimal form to support their statement of fairness.

3- All required elements are included.
The project must be neatly done.
Directions for the game should be understandable.
Most directions are included, with few omissions or contradictions.

2- The game is not fair.
It may be difficult or complex to play.
The directions are not written clearly.
The student does not use fractions or decimals, but otherwise mathematically describes fairness.

1- The game is not fair.
The game cannot be played based on the given directions.
The statement of fairness evidences an attempt to describe fairness, but does not use theoretical probability.

0- The project is not turned in.
-or-
Not all of the required elements are included.
The students' game is off topic, off task, or uses inappropriate material.